

# SN5413, SN54LS13, SN7413, SN74LS13

## DUAL 4-INPUT POSITIVE-NAND SCHMITT TRIGGERS

DECEMBER 1983—REVISED MARCH 1988

- Operation from Very Slow Edges
- Improved Line-Receiving Characteristics
- High Noise Immunity

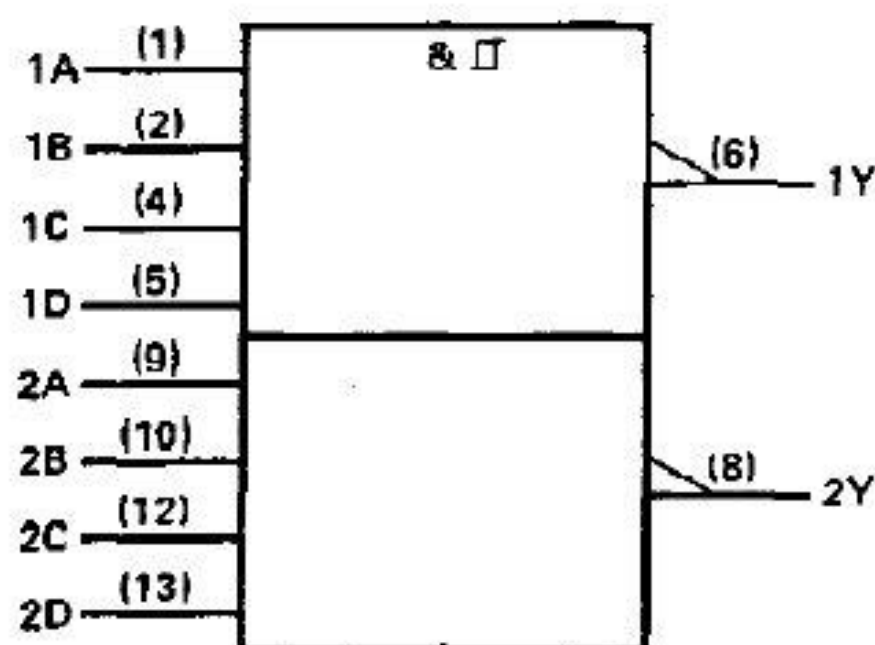
### description

Each circuit functions as a 4-input NAND gate, but because of the Schmitt action, it has different input threshold levels for positive ( $V_{T+}$ ) and for negative going ( $V_{T-}$ ) signals.

These circuits are temperature-compensated and can be triggered from the slowest of input ramps and still give clean, jitter-free output signals.

The SN5413 and SN54LS13 are characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN7413 and SN74LS13 are characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .

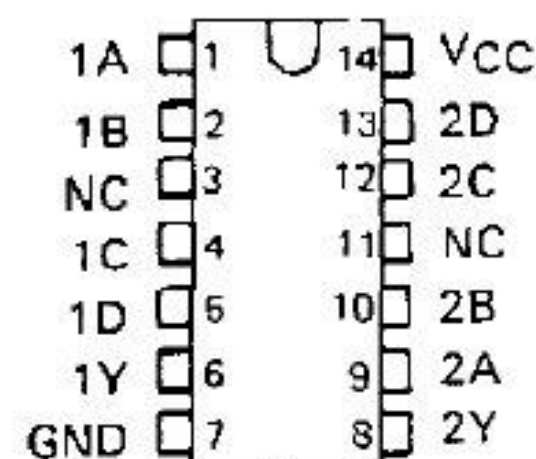
### logic symbol†



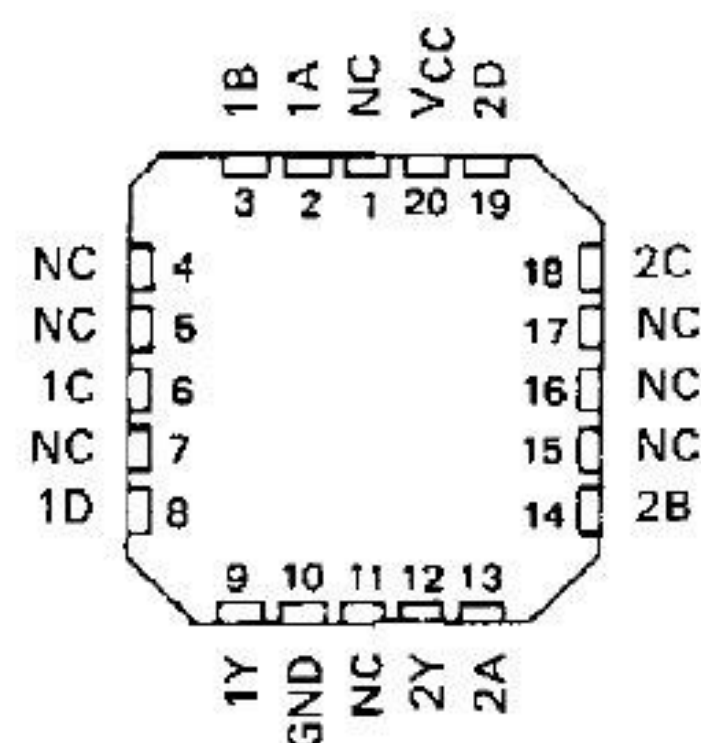
† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-13.

Pin numbers shown are for D, J, N, and W packages.

SN5413, SN54LS13 . . . J OR W PACKAGE  
SN7413 . . . N PACKAGE  
SN74LS13 . . . D OR N PACKAGE  
(TOP VIEW)

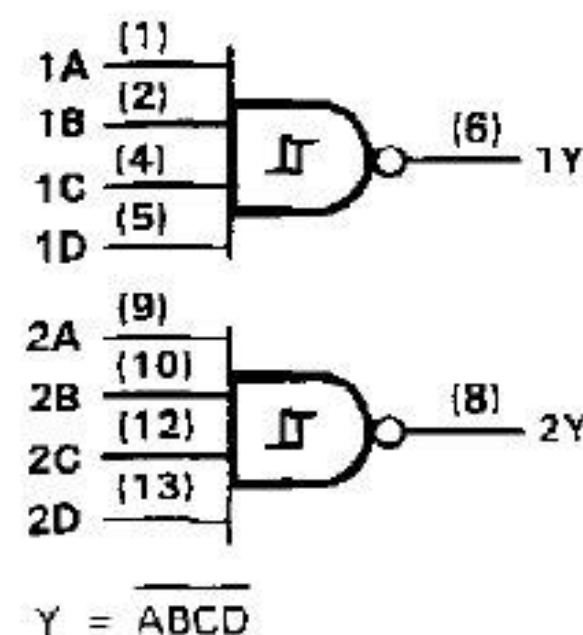


SN54LS13 . . . FK PACKAGE  
(TOP VIEW)



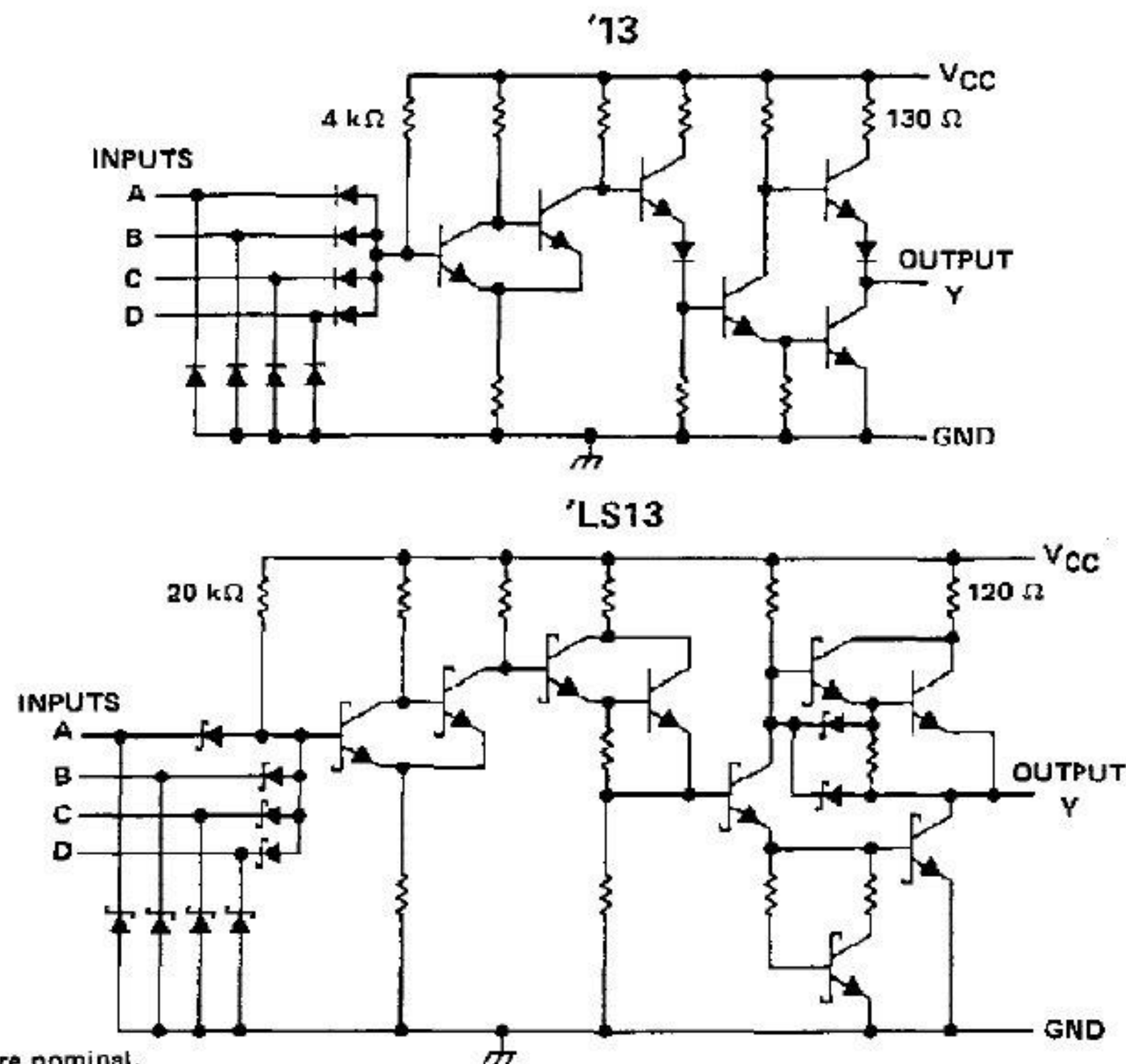
NC—No internal connection

### logic diagram (positive logic)



# SN5413, SN54LS13, SN7413, SN74LS13 DUAL 4-INPUT POSITIVE-NAND SCHMITT TRIGGERS

schematics



Resistor values are nominal.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, $V_{CC}$ (see Note 1)	7 V
Input voltage: '13	5.5 V
'LS13	7 V
Operating free-air temperature: SN54'	$-55^{\circ}\text{C}$ to $125^{\circ}\text{C}$
SN74'	$0^{\circ}\text{C}$ to $70^{\circ}\text{C}$
Storage temperature range	$-65^{\circ}\text{C}$ to $150^{\circ}\text{C}$

NOTE 1: Voltage values are with respect to network ground terminal.

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**SN5413, SN7413**  
**DUAL 4-INPUT**  
**POSITIVE-NAND SCHMITT TRIGGERS**

**recommended operating conditions**

	SN5413			SN7413			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	
$V_{CC}$ Supply voltage	4.5	5	5.5	4.75	5	5.25	V
$I_{OH}$ High-level output current			-0.8			-0.8	mA
$I_{OL}$ Low-level output current			16			16	mA
$T_A$ Operating free-air temperature	-55		125	0		70	°C

**electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)**

PARAMETER	TEST CONDITIONS†	MIN	TYP‡	MAX	UNIT
$V_{T+}$	$V_{CC} = 5\text{ V}$	1.5	1.7	2	V
$V_{T-}$	$V_{CC} = 5\text{ V}$	0.6	0.9	1.1	V
Hysteresis ( $V_{T+} - V_{T-}$ )	$V_{CC} = 5\text{ V}$	0.4	0.8		V
$V_{IK}$	$V_{CC} = \text{MIN.}$ , $I_I = -12\text{ mA}$			-1.5	V
$V_{OH}$	$V_{CC} = \text{MIN.}$ , $V_I = 0.6\text{ V}$ , $I_{OH} = -0.8\text{ mA}$	2.4	3.4		V
$V_{OL}$	$V_{CC} = \text{MIN.}$ , $V_I = 2\text{ V}$ , $I_{OL} = 16\text{ mA}$		0.2	0.4	V
$I_{T+}$	$V_{CC} = 5\text{ V}$ , $V_I = V_{T+}$	-0.65			mA
$I_{T-}$	$V_{CC} = 5\text{ V}$ , $V_I = V_{T-}$	-0.85			mA
$I_I$	$V_{CC} = \text{MAX.}$ , $V_I = 5.5\text{ V}$			1	mA
$I_{IH}$	$V_{CC} = \text{MAX.}$ , $V_{IH} = 2.4\text{ V}$			40	μA
$I_{IL}$	$V_{CC} = \text{MAX.}$ , $V_{IL} = 0.4\text{ V}$		-1	-1.6	mA
$I_{OS} §$	$V_{CC} = \text{MAX.}$	-18		-55	mA
$I_{CCH}$	$V_{CC} = \text{MAX.}$		14	23	mA
$I_{CCL}$	$V_{CC} = \text{MAX.}$		20	32	mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ All typical values are at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

§ Not more than one output should be shorted at a time.

**switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$**

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{PLH}$	Any	Y	$R_L = 400\ \Omega$ , $C_L = 15\text{ pF}$		18	27	ns
$t_{PHL}$					15	22	ns

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# SN54LS13, SN74LS13 DUAL 4-INPUT POSITIVE-NAND SCHMITT TRIGGERS

## recommended operating conditions

	SN54LS13			SN74LS13			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	
$V_{CC}$ Supply voltage	4.5	5	5.5	4.75	5	5.25	V
$I_{OH}$ High-level output current			-0.4			-0.4	mA
$I_{OL}$ Low-level output current			4			8	mA
$T_A$ Operating free-air temperature	-55		125	0		70	°C

## electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†	SN54LS13			SN74LS13			UNIT
		MIN	TYP‡	MAX	MIN	TYP‡	MAX	
$V_{T+}$	$V_{CC} = 5\text{ V}$	1.4	1.0	1.9	1.4	1.6	1.9	V
$V_{T-}$	$V_{CC} = 5\text{ V}$	0.5	0.8	1	0.5	0.8	1	V
Hysteresis ( $V_{T+} - V_{T-}$ )	$V_{CC} = 5\text{ V}$	0.4	0.8		0.4	0.8		V
$V_{IK}$	$V_{CC} = \text{MIN.}$ $I_I = -18\text{ mA}$			-1.5			-1.5	V
$V_{OH}$	$V_{CC} = \text{MIN.}$ $V_I = 0.5\text{ V}$ $I_{OH} = -0.4\text{ mA}$	2.5	3.4		2.7	3.4		V
$V_{OL}$	$V_{CC} = \text{MIN.}$ $V_I = 1.9\text{ V}$			$I_{OL} = 4\text{ mA}$			$I_{OL} = 4\text{ mA}$	V
				$I_{OL} = 8\text{ mA}$			$I_{OL} = 8\text{ mA}$	
$I_{T+}$	$V_{CC} = 5\text{ V}$ $V_I = V_{T+}$	-0.14			-0.14			mA
$I_{T-}$	$V_{CC} = 5\text{ V}$ $V_I = V_{T-}$	-0.18			-0.18			mA
$I_I$	$V_{CC} = \text{MAX.}$ $V_I = 7\text{ V}$	0.1			0.1			mA
$I_{IH}$	$V_{CC} = \text{MAX.}$ $V_{IH} = 2.7\text{ V}$	20			20			µA
$I_{IL}$	$V_{CC} = \text{MAX.}$ $V_{IL} = 0.4\text{ V}$	-0.4			-0.4			mA
$I_{OS}§$	$V_{CC} = \text{MAX.}$	-20		-100	-20		-100	mA
$I_{CCH}$	$V_{CC} = \text{MAX.}$	2.9			2.9			mA
$I_{CCL}$	$V_{CC} = \text{MAX.}$	4.1			4.1			mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ All typical values are at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

§ Not more than one output should be shorted at a time, and duration of the short-circuit should not exceed one second.

## switching characteristics, $V_{CC} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{PLH}$	Any	Y	$R_L = 2\text{ k}\Omega$ , $C_L = 15\text{ pF}$		15	22	ns
$t_{PHL}$					18	27	ns

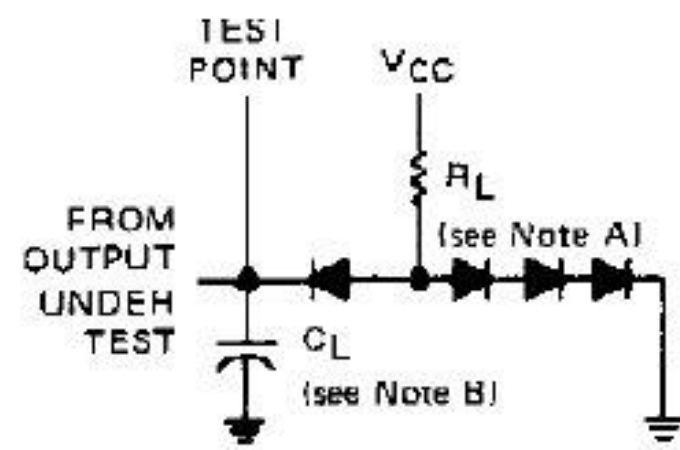
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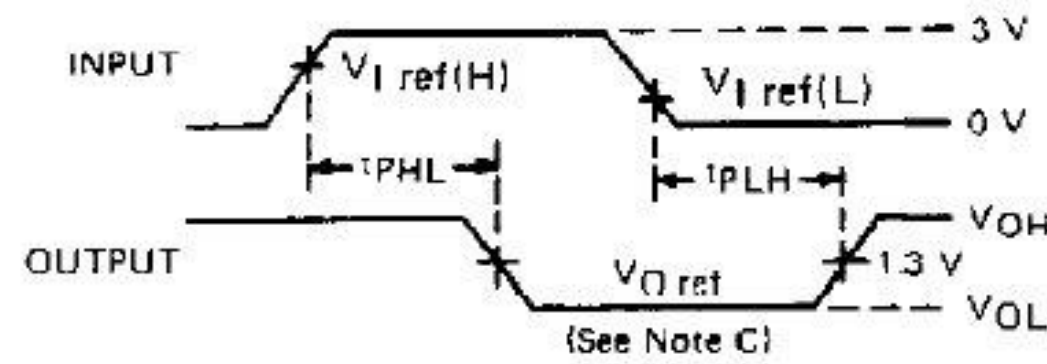
# SN5413, SN54LS13, SN7413, SN74LS13

## DUAL 4-INPUT POSITIVE-NAND SCHMITT TRIGGERS

### PARAMETER MEASUREMENT INFORMATION



LOAD CIRCUIT



VOLTAGE WAVEFORMS

- NOTES: A. All diodes are 1N3064 or equivalent.  
B.  $C_L$  includes probe and jig capacitance.  
C. Generator characteristics and reference voltages are:

	Generator Characteristics				Reference Voltages		
	$Z_{out}$	PRR	$t_r$	$t_f$	$V_{I \text{ ref(H)}}$	$V_{I \text{ ref(L)}}$	$V_{O \text{ ref}}$
SN54/SN74 <sup>*</sup>	50 $\Omega$	1 MHz	10 ns	10 ns	1.7 V	0.9 V	1.5 V
SN54LS/SN74LS <sup>*</sup>	50 $\Omega$	1 MHz	15 ns	6 ns	1.6 V	0.8 V	1.3 V

### TYPICAL CHARACTERISTICS OF '13 CIRCUITS

POSITIVE-GOING THRESHOLD VOLTAGE

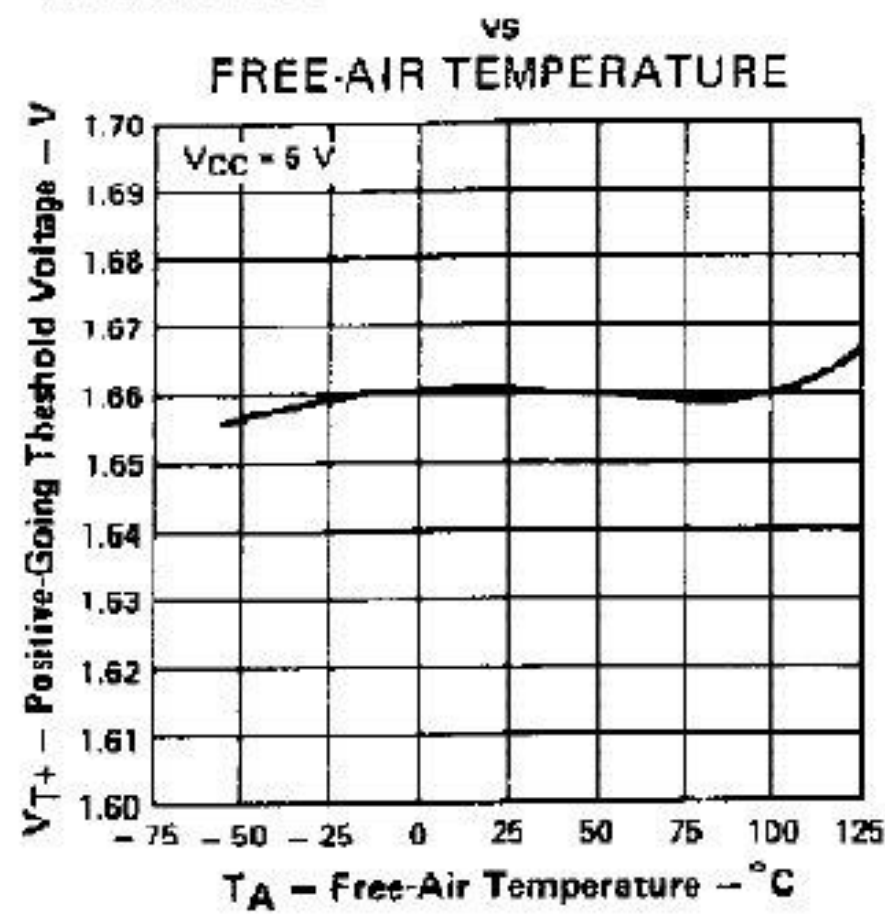


FIGURE 1

NEGATIVE-GOING THRESHOLD VOLTAGE

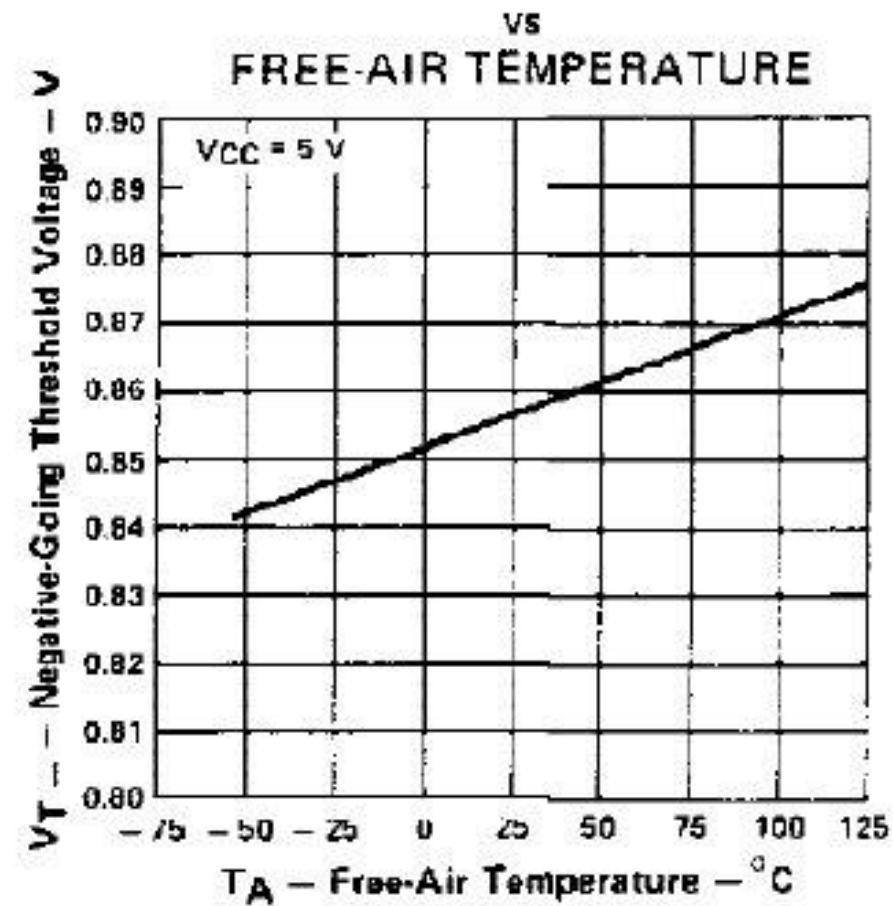


FIGURE 2

HYSTERESIS

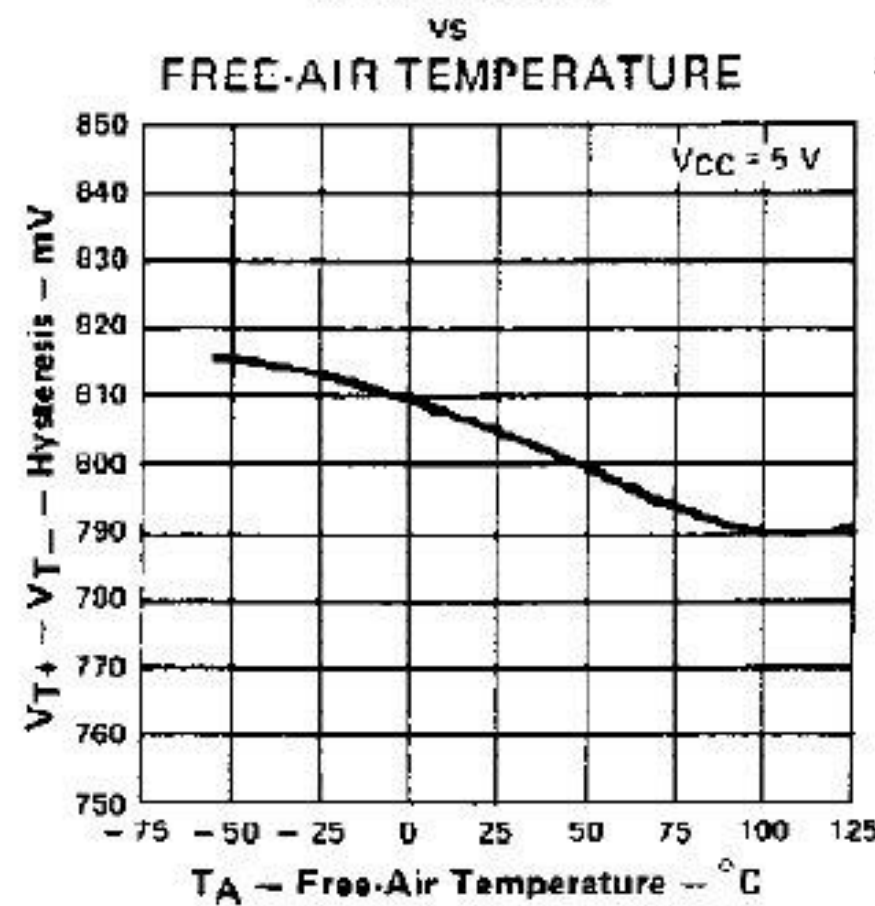


FIGURE 3

Data for temperatures below  $0^{\circ}\text{C}$  and  $70^{\circ}\text{C}$  and supply voltages below 4.75 V and above 5.25 V are applicable for SN5413 only.

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**TYPICAL CHARACTERISTICS OF '13 CIRCUITS**

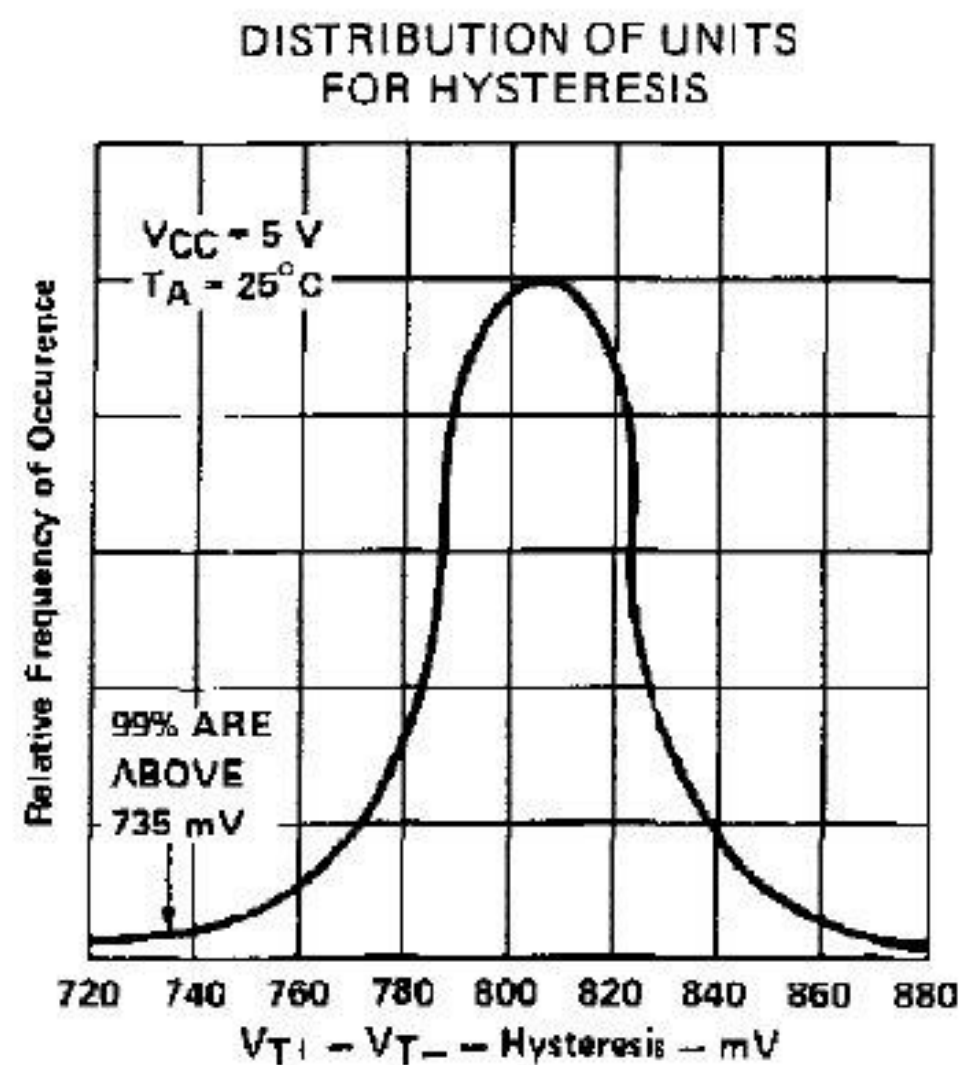


FIGURE 4

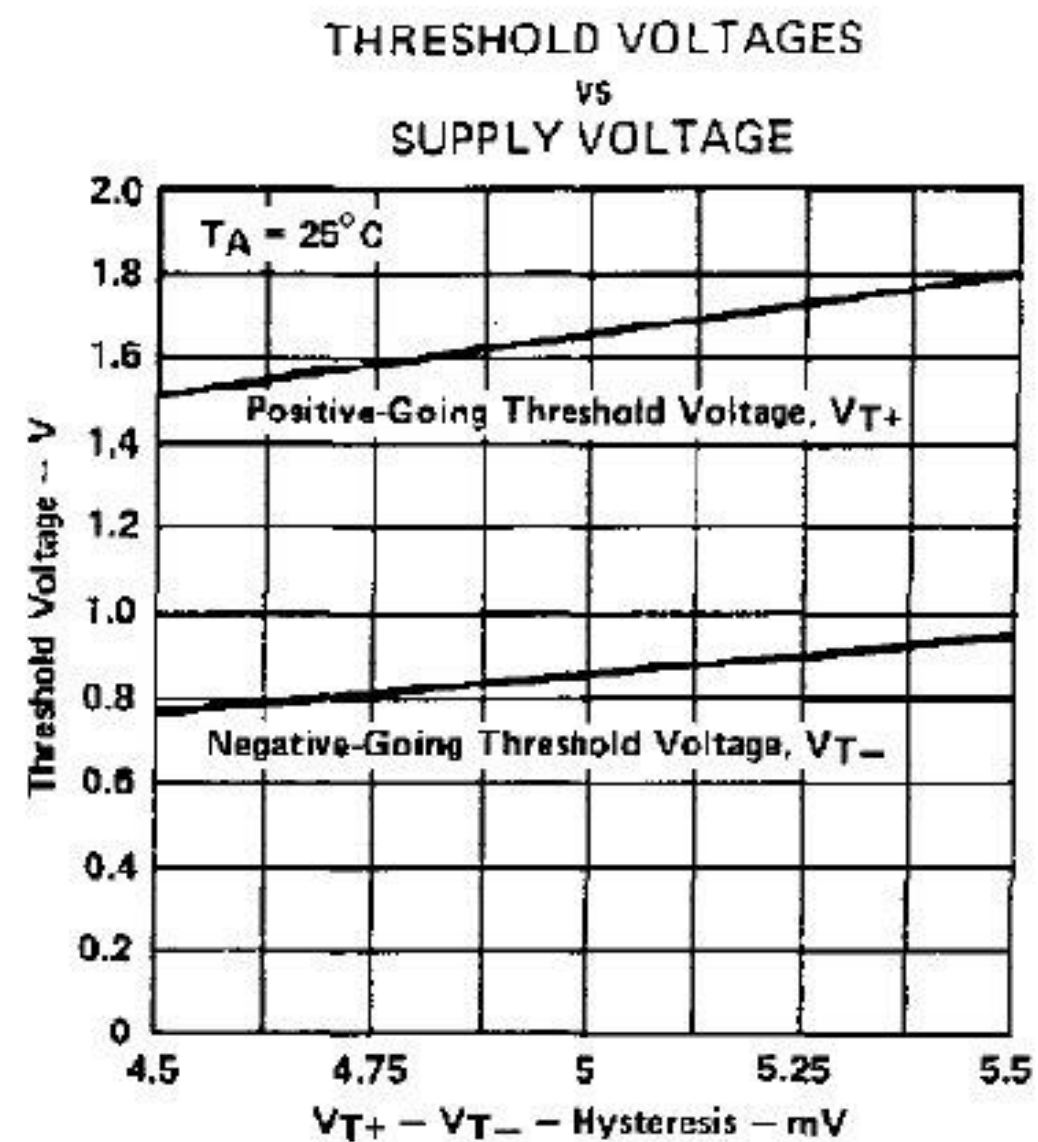


FIGURE 5

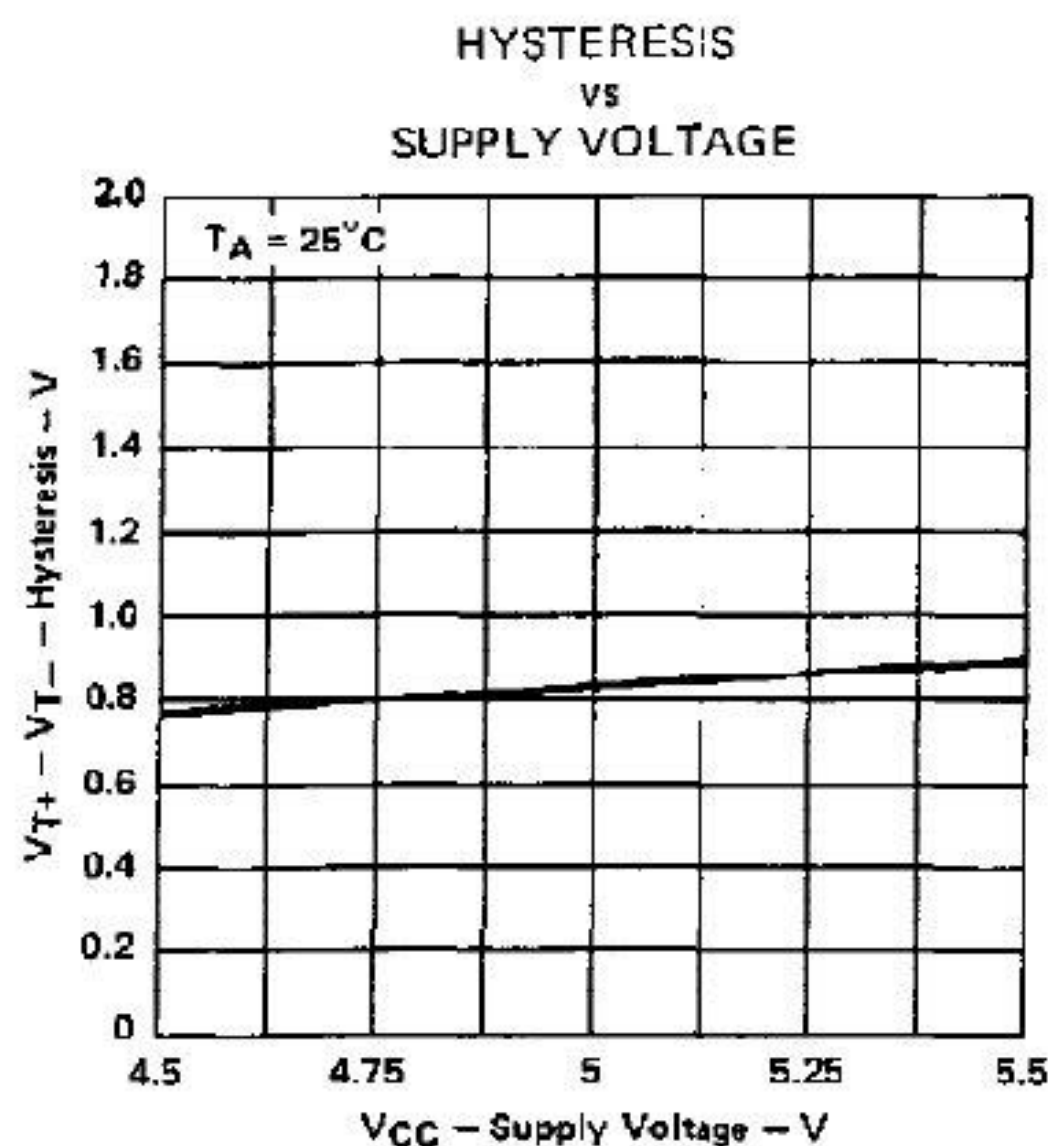


FIGURE 6

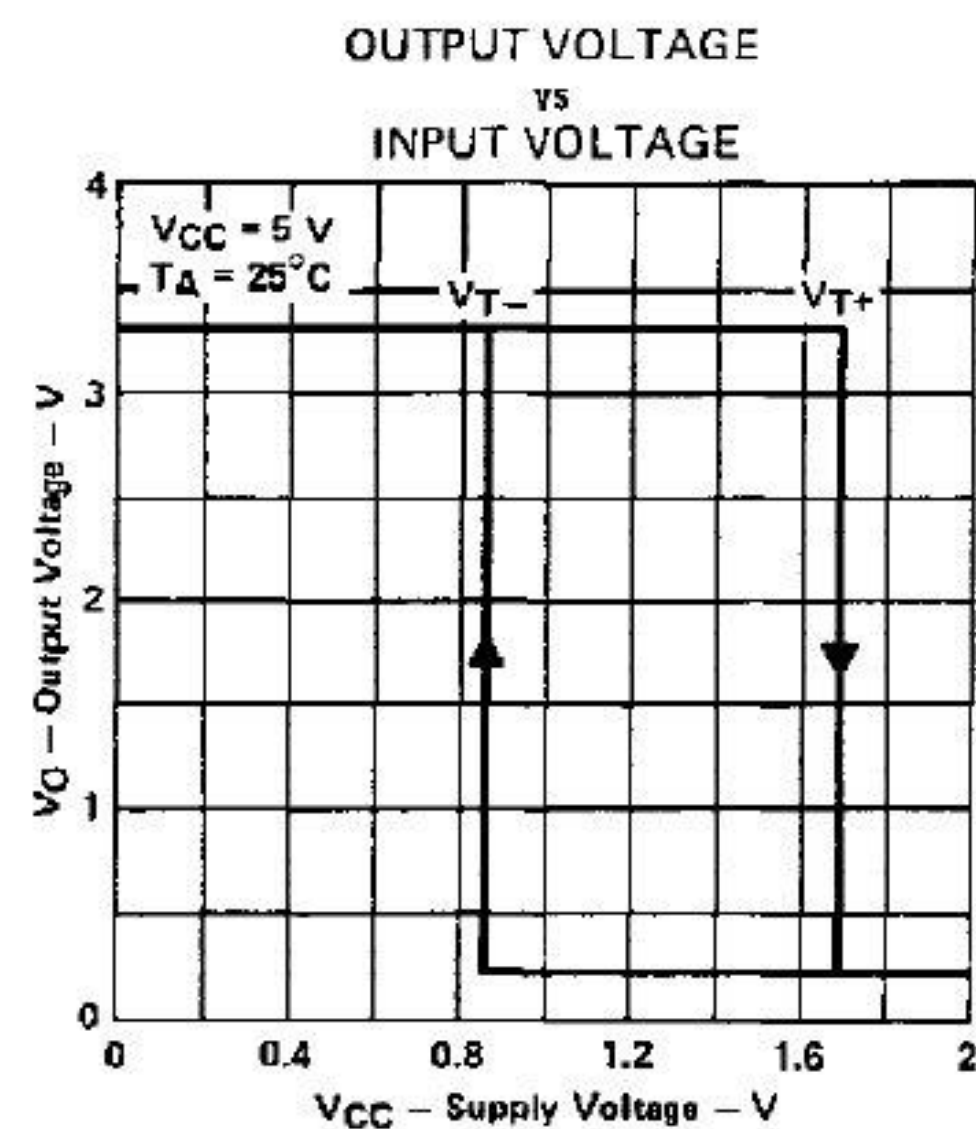


FIGURE 7

Data for temperatures below  $0^\circ\text{C}$  and  $70^\circ\text{C}$  and supply voltages below 4.75 V and above 5.25 V are applicable for SN5413 only.

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TYPICAL CHARACTERISTICS OF 'LS13 CIRCUITS

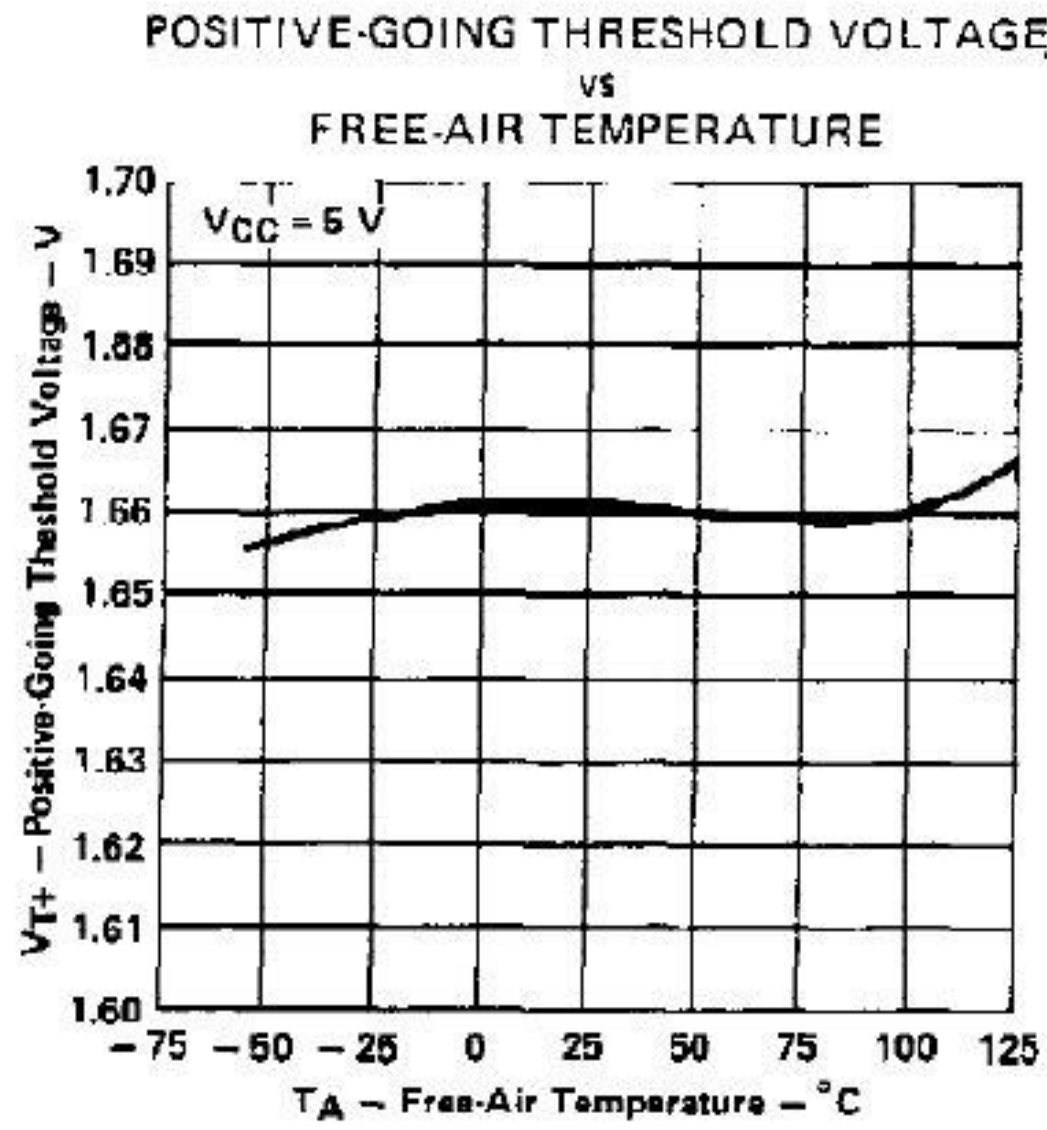


FIGURE 8

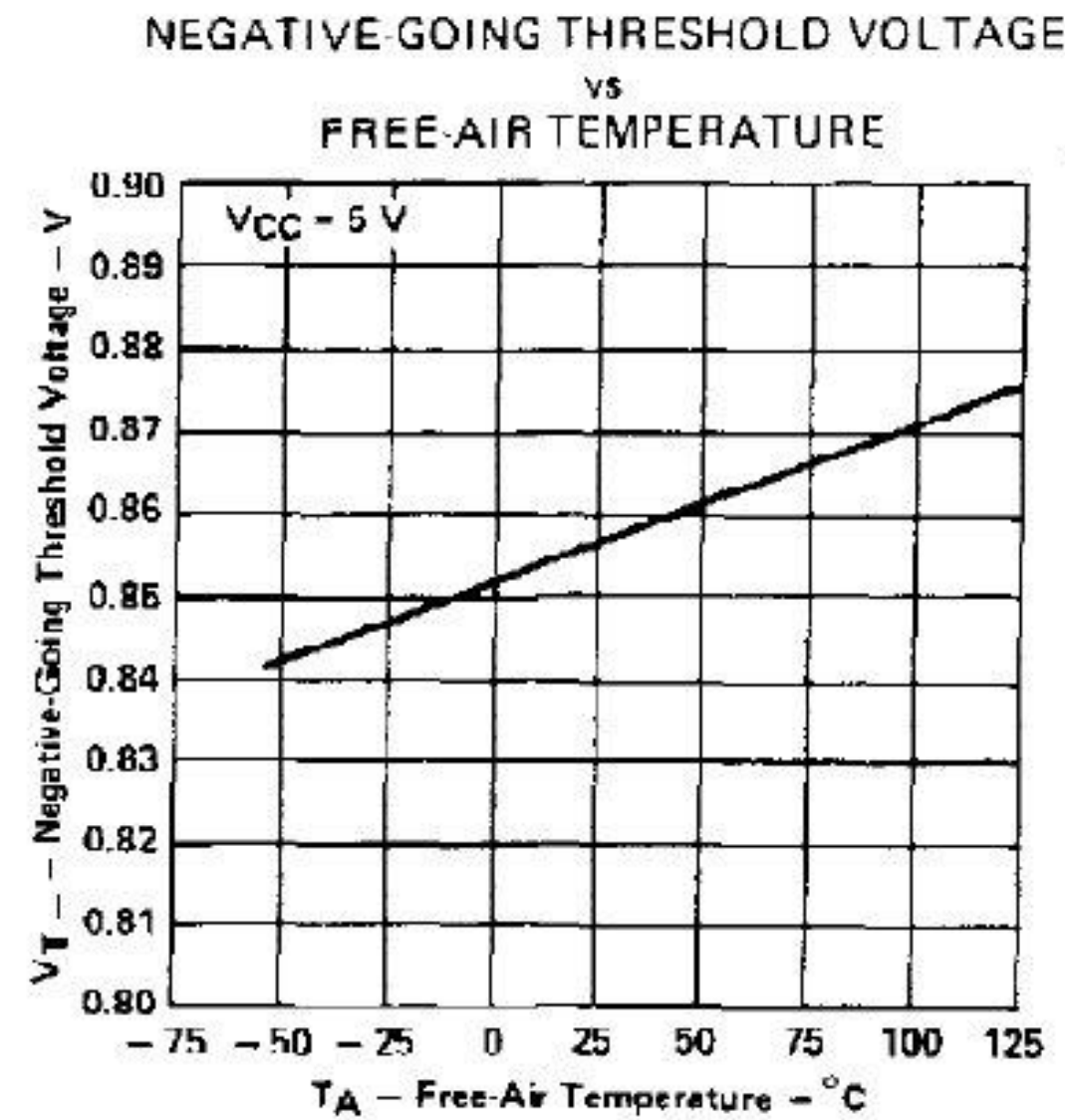


FIGURE 9

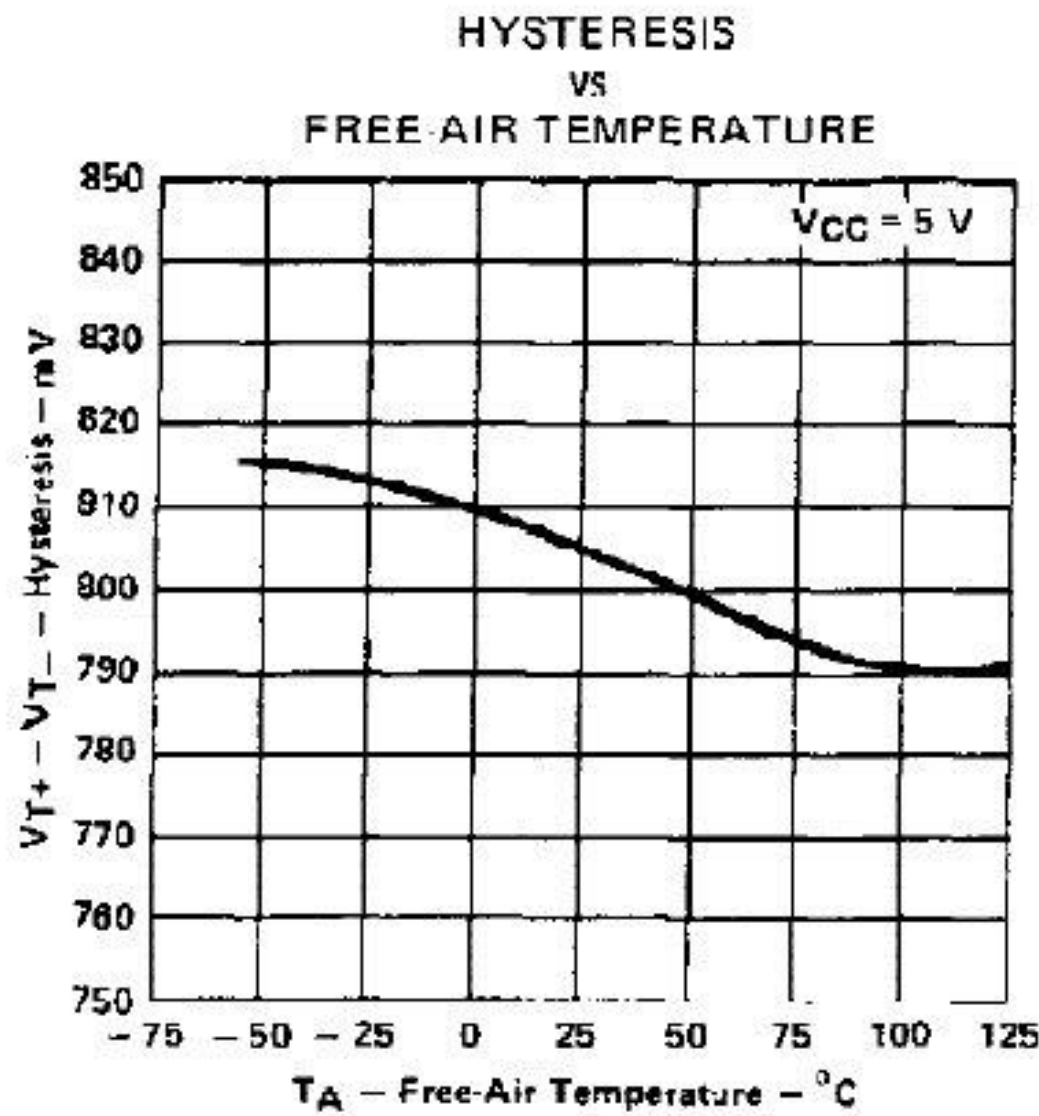


FIGURE 10

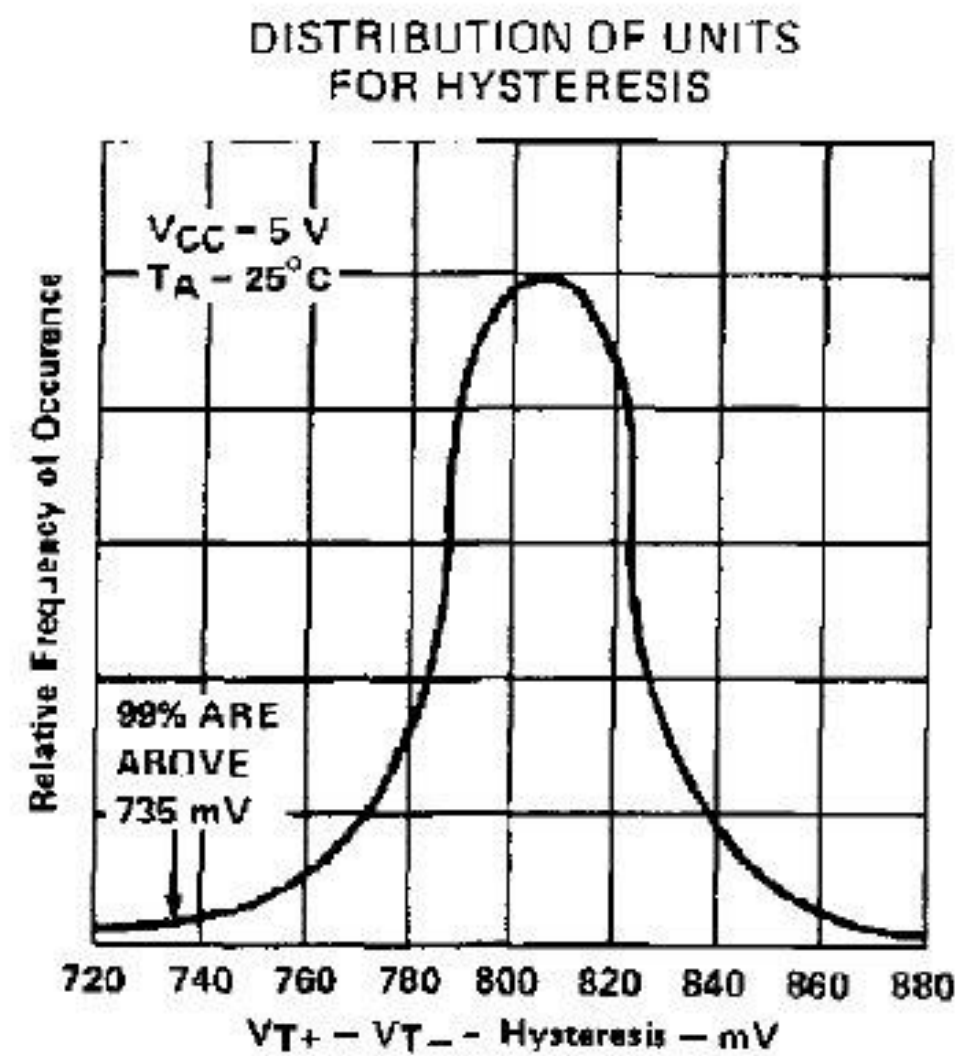


FIGURE 11

Data for temperatures below 0°C and above 70°C and supply voltages below 4.75 V and above 5.25 V are applicable for SN54LS13 only.

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**DUAL 4-INPUT**  
**POSITIVE-NAND SCHMITT TRIGGERS**

**TYPICAL CHARACTERISTICS OF 'LS13 CIRCUITS**

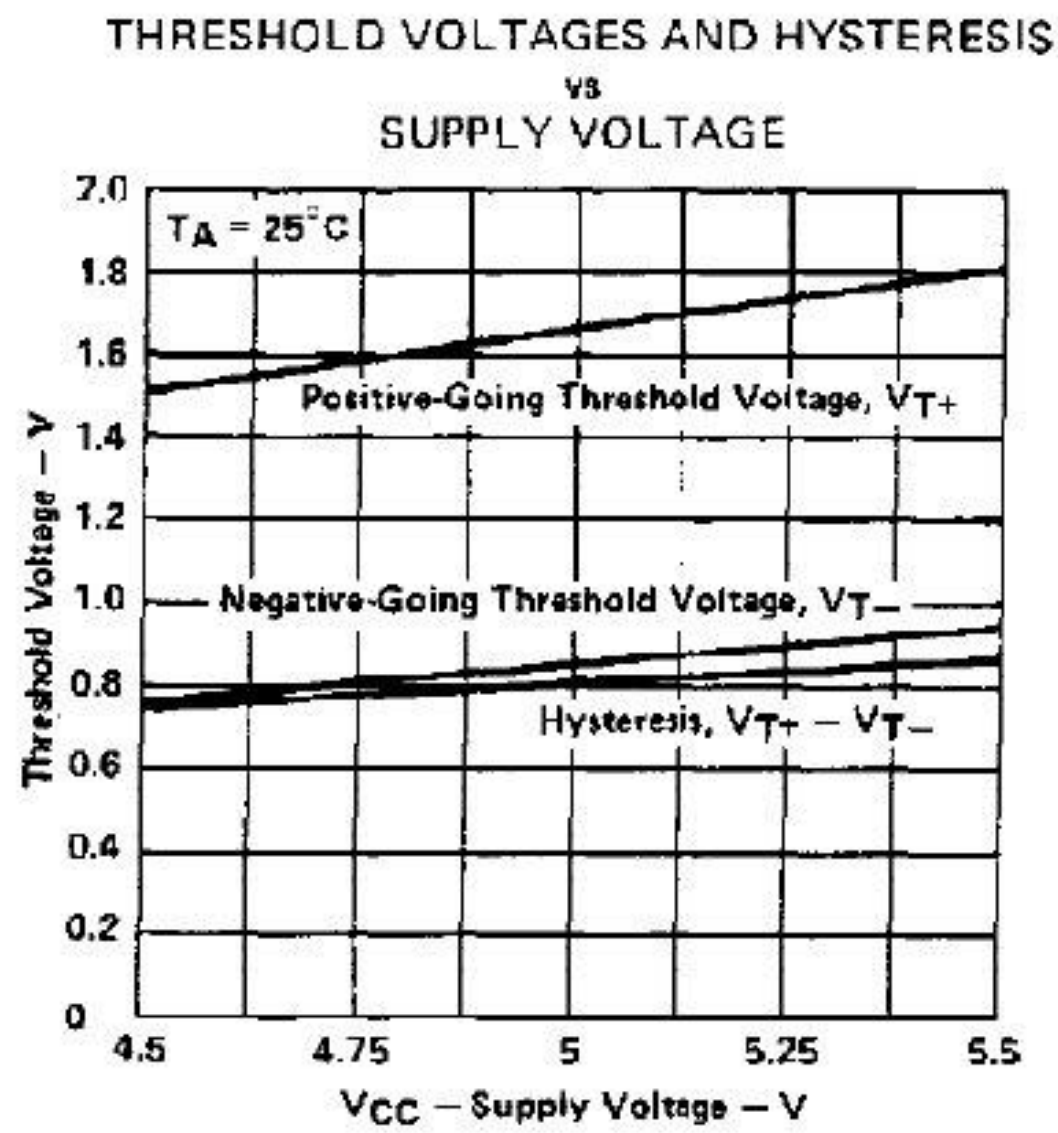


FIGURE 12

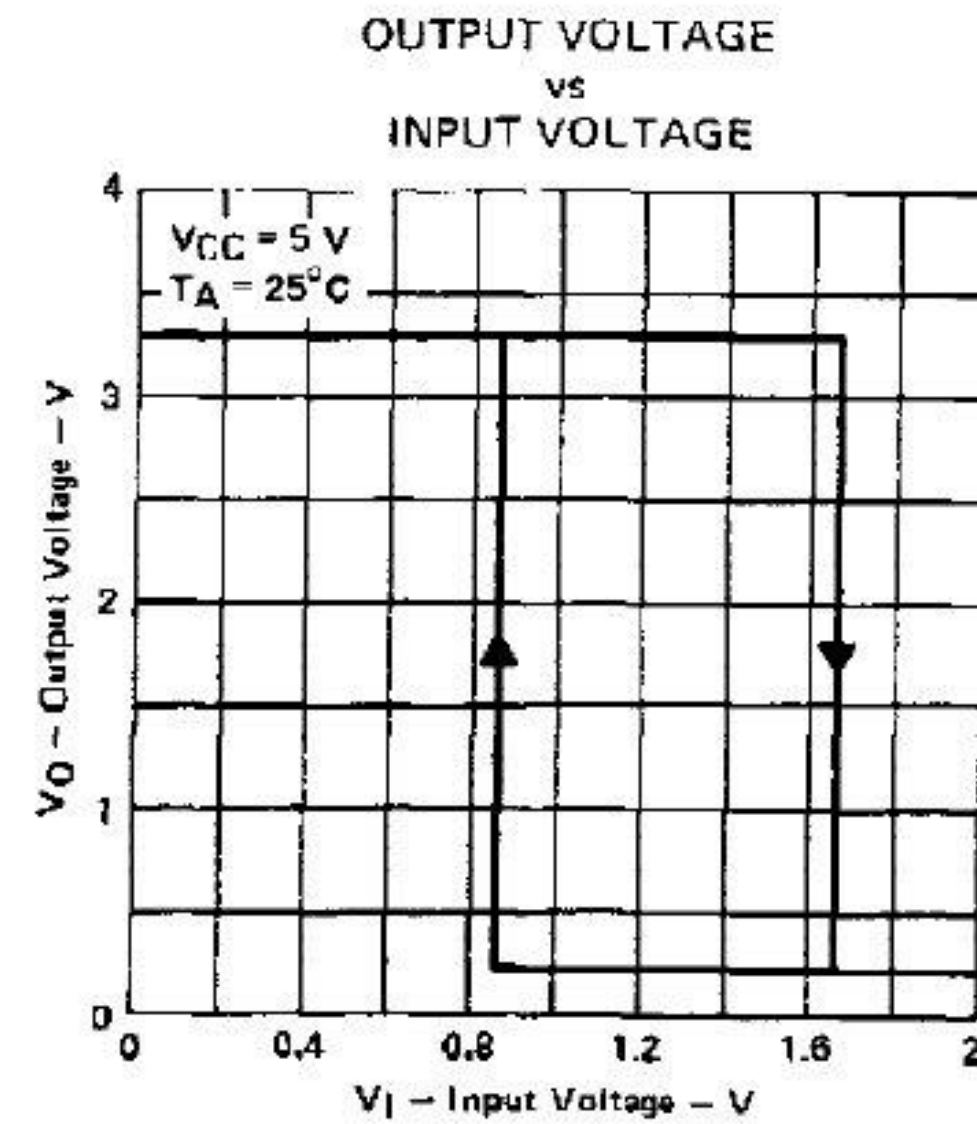


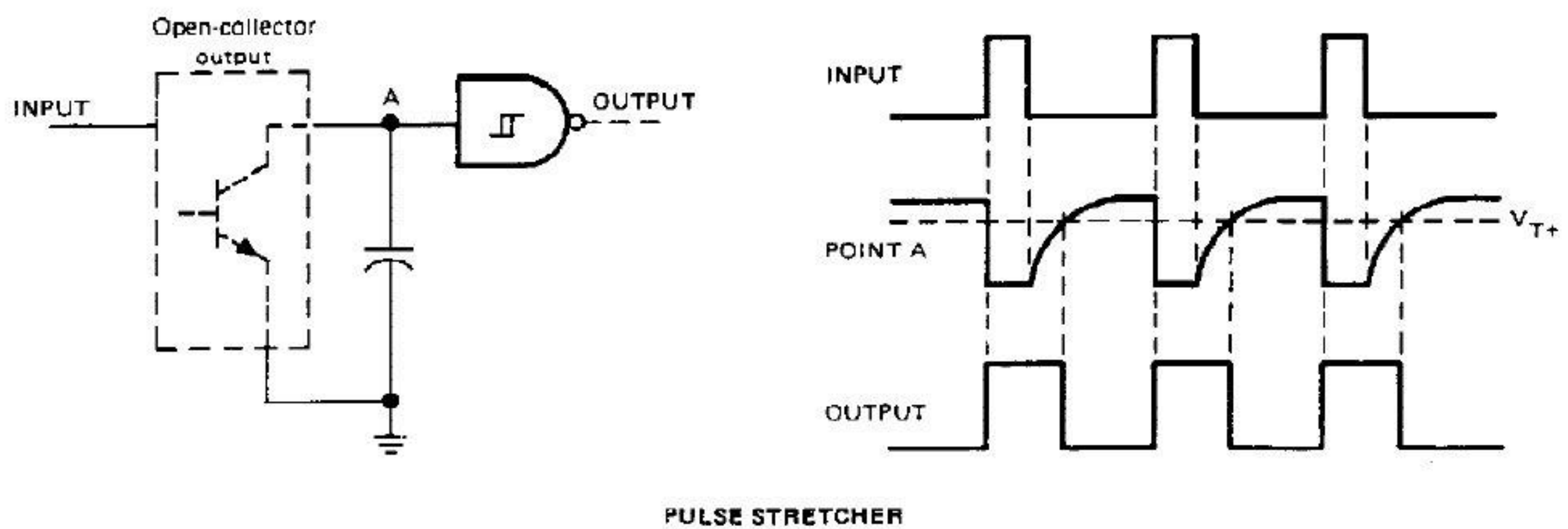
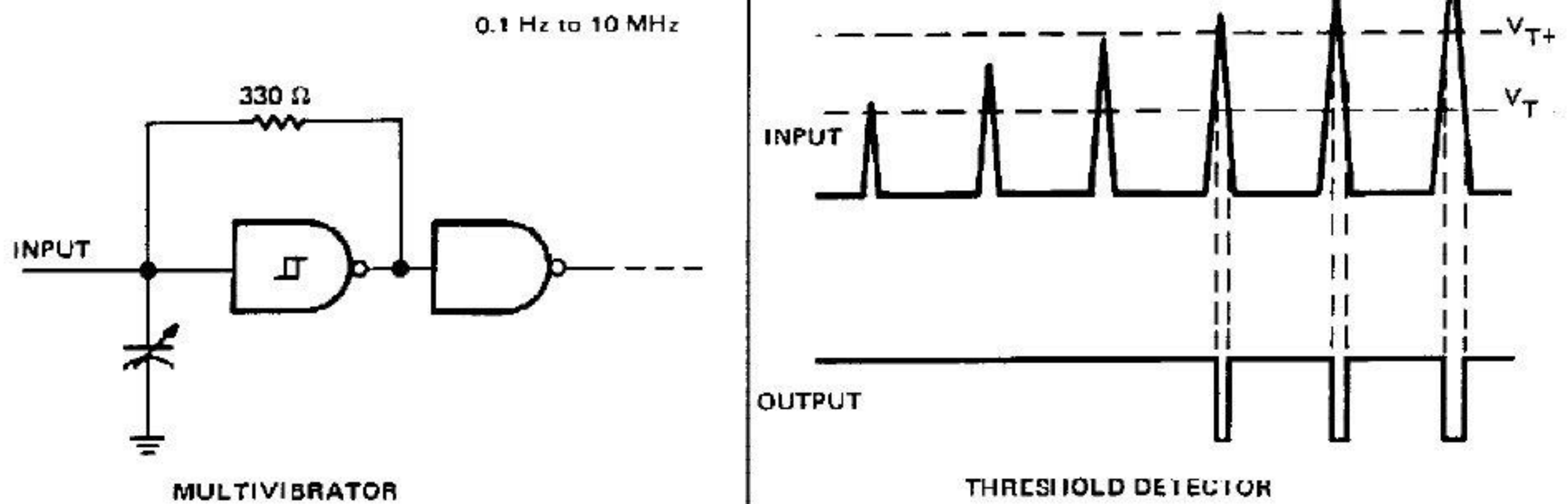
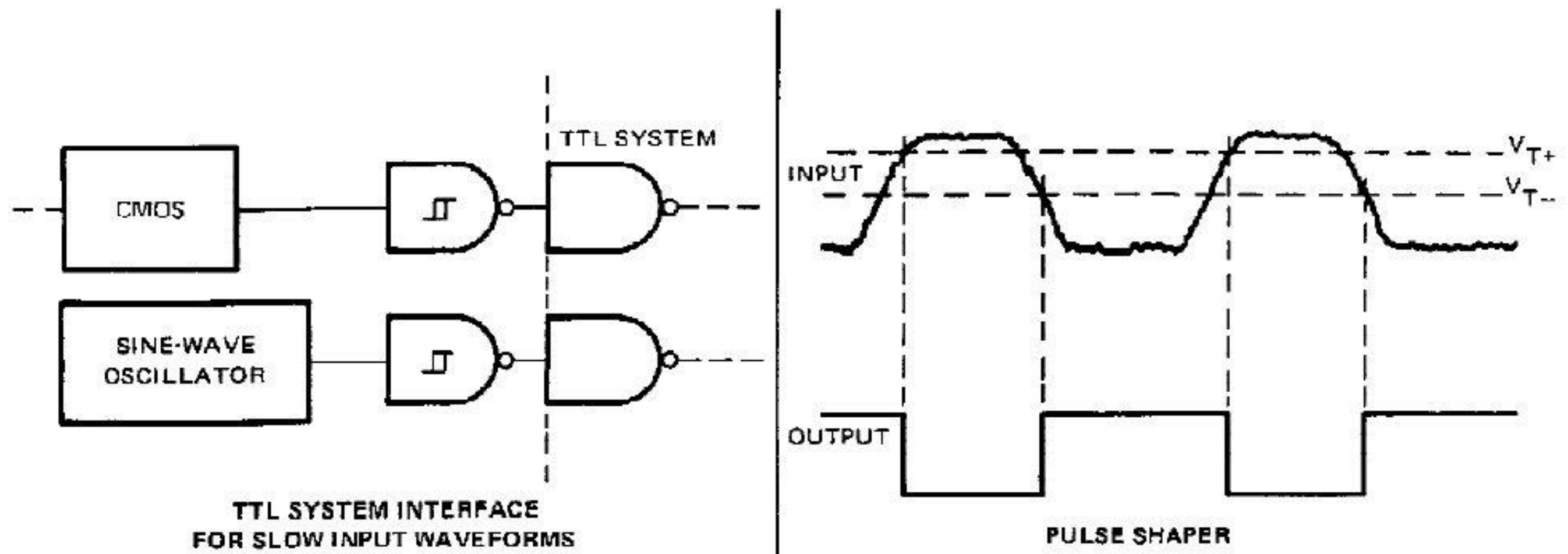
FIGURE 13

Data for temperatures below 0°C and above 70°C and supply voltages below 4.75 V and above 5.25 V are applicable for SN54LS13 only.



SN5413, SN54LS13, SN7413, SN74LS13  
DUAL 4-INPUT  
POSITIVE-NAND SCHMITT TRIGGERS

TYPICAL APPLICATION DATA



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